Technical Standard Order

Subject: TSO-C69b, EMERGENCY EVACUATION SLIDES, RAMPS, AND SLIDE/RAFT COMBINATIONS

(a) Applicability.

(1) Minimum Performance Standards. This Technical Standard Order (TSO) prescribes the minimum performance standards that emergency evacuation slides, ramps, and slide/raft combinations must meet to be identified with the applicable TSO marking. This TSO has been prepared in accordance with the procedural rules set forth in Subpart O of the Federal Aviation Regulations Part 21. New models of emergency evacuation slides, ramps, and slide/raft combinations that are to be so identified and that are manufactured on or after the effective date of this TSO must meet the standards set forth in Appendix 1, "Federal Aviation Administration Standards for Emergency Evacuation Slides, Ramps, and Slide/Raft Combinations," and Appendix 2, "Radiant Heat Testing of Material in Inflatable Emergency Evacuation Slides, Ramps, and Slide/Raft Combinations" of this TSO.

(2) Environmental Standard. None.

(3) Test Methods. This TSO references Federal Test Method Standard No. 191A dated 7/20/78.

(b) Marking. In addition to the marking required in Federal Aviation Regulations (FAR) § 21.607(d) (14 CFR 21.607), an emergency evacuation slide, ramp, or slide/raft combination must be marked with the part number, serial number and date of manufacture; and for a slide/raft combination, rated and overload capacities and weight must be shown. The weight of the slide/raft combination includes any accessories required in this TSO.

DISTRIBUTION: ZVS-326;A-W(WS)-3;A-X(CD)-4;A-FFS-1,2,7,8(LTD);A-X(FS)-3;

(1) Operating instructions.

(2) Packing instructions.

(3) A complete description of the device, including detailed drawings, materials identification and specifications, and installation procedures.

(4) Manufacturer's TSO qualification test report.

(5) Applicable installation limitations, including stowage area temperatures. The manufacturer shall also provide the purchaser with such limitations.

(6) Maintenance instructions, including instructions regarding inspection, repair, and stowage of materials.

(7) The functional test specification to be used to test each production article to ensure compliance with this TSO.

(d) Previously Approved Equipment. Pursuant to FAR Section 21.621, each TSO-C69 authorization, to the extent it authorizes the holder to identify or mark emergency evacuation slides with TSO-C69, is withdrawn for inflatable emergency evacuation devices which do not comply with Appendix 2 of either TSO-C69a or TSO-C69b.

(e) Availability of Referenced Documents.

(1) Appendix 1, "Federal Aviation Administration Standards for Emergency Evacuation Slides, Ramps, and Slide/Raft Combinations," of this TSO specifies certain test methods that are contained in Federal Test Method Standard No. 191A unless otherwise noted. Federal Test Method Standard No. 191A may be examined at the FAA Headquarters in the Aircraft Certification Service, Aircraft Engineering Division (AIR-120), and at all aircraft certification offices, and may be obtained (or purchased) from the General Services Administration, Business Service Center, Region 3, 7th and D Streets, SW., Washington, DC 20407.

William Sullivan

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1. Purpose. Part I of this standard provides the minimum performance standards for inflatable emergency evacuation slides and overwing exit ramps. (Note: FAR Part 25 contains additional requirements pertaining to inflatable emergency evacuation devices as installed on the aircraft which may be taken into consideration along with the requirements in this TSO.)

2. Scope. Part I of this standard provides for the following three types of devices: (a) inflatable evacuation slide devices suitable for assisting occupants in descending to the ground from floor-level aircraft exits and from aircraft wings, (b) inflatable emergency exit ramp devices suitable for assisting occupants in descending to aircraft wings from certain overwing exits, and (c) combination inflatable emergency exit ramp and wing-to-ground slide devices.

3. Material and Workmanship.

3.1 Nonmetallic Materials.

3.1.1 The finished device must be clean and free from any defects that might affect its function.

3.1.2 Coated fabrics and other items, such as webbing, subject to deterioration must have been manufactured not more than 18 months prior to the date of delivery of the finished product.

3.1.3 The materials must not support fungus growth.

3.1.4 Coated fabrics - General. Coated fabrics, including seams, subject to deterioration used in the manufacture of the devices must possess at least 90 percent of their original physical properties after these fabrics have been subjected to the accelerated ageing test specified in paragraph 5 (Part I) of this standard.

3.1.4.1 Strength. Coated fabrics used for these applications must conform to the following minimum strengths after ageing:

Tensile Strength (Grab Test)
Warp 190 pounds/inch
Fill 190 pounds/inch

Tear Strength (Trapezoid Test or Tongue Test)
Surfaces except walking/sliding surface: 13 X 13 pounds/inch (minimum)
Walking/Sliding surface: 50 X 50 pounds/inch (minimum)

Puncture Strength - Walking/Sliding surface
67 pounds force

5 pounds/inch width at 70 ± 2 degrees F at a pull of 2.0 to 2.5 inches/minute

Coat Adhesion -
5 pounds/inch width at 70 ± 2 degrees F at 2.0 to 2.5 inches/minute

3.1.4.3 Permeability. For coated fabrics used in the manufacture of inflation chambers, the maximum permeability to helium (Permeability Test Method) may not exceed 10 liters per square meter in 24 hours at 77 degrees F, or its equivalent using hydrogen. The permeameter must be calibrated for the gas used. In lieu of this permeability test, an alternate test may be used provided the alternate test has been approved as an equivalent to this permeability test by the manager of the FAA office to which this TSO data is to be submitted, as required in Paragraph (c), Data Requirements.

3.1.4.4 Hydrolysis. Pressure holding coated fabrics, including seams, must be shown to be resistant to hydrolysis, as follows. It must be shown by tests specified in 5.0 that the porosity of the basic pressure holding material is not increased as a result of the material being subjected to hydrolysis conditioning. Seam strength and coat adhesion must not be reduced more than 20% and still not fall below the minimums prescribed in paragraphs 3.1.4.2 and 3.1.5 as a result of hydrolysis conditioning.

3.1.5 Seam Strength and Adhesives. Cemented or heat sealable seams used in the manufacture of the device must meet the following minimum strength requirements:

Shear Strength (Seam Shear Test Method) - 175 pounds/inch width at 75 degrees F
40 pounds/inch width at 140 degrees F

Peel Strength (Peel Test Method) -
5 pounds/inch width at 70 degrees F

3.1.6 Seam Tape. If tape is used for seam reinforcement or abrasion protection of seams or both, the tape must have minimum breaking strength (Grab Test Method) of 40 pounds/inch width in both the warp and fill directions. When applied to the seam area, the adhesion strength characteristics must meet the seam strength requirements in paragraph 3.1.5.

3.1.7 Flammability. The device (including carrying case or stowage container) must be constructed of materials which meet paragraph (b) of FAR § 25.853 (14 CFR 25.853) in effect on May 1, 1972.

chafing or abrasion of the material in either the packed or the inflated condition.

4. Design and Construction.

4.1 Operation. The operation of the device must be simple enough so that brief, easily understood, posted instructions can be followed by the user.

4.2 Function. The device, including its inflation system, must be capable of functioning when subjected to temperatures from -40 degrees F to +160 degrees F. In addition, if the device is intended for installation outside the pressurized cabin, the device must be capable of being stowed at -65 degrees F without damage.

4.3 Strength. The device, installed at its critical angle, may not collapse when loaded to its maximum capacity as determined by a test in which a sufficient number of adult (170 pounds or more) evacuees crowd closely in line at the top of each lane of the device and jump into the device in rapid succession at a rate not less than one evacuee per second per lane. It must demonstrate the means used to connect the device to the aircraft will not fail when the device is operated at low angles (from horizontal) and at maximum evacuee loading conditions (including asymmetrical loading) expected in service. Unless a rational loads analysis is provided which substantiates a different loading condition, and is approved by the manager of the FAA office to which this TSO data is to be submitted as required in paragraph (c), Data Requirements, the angles and loads selected may not be greater than 30 degrees and less than 1,050 pounds per lane, respectively. If the device is equipped with outrigger pontoons, additional test loads must be applied to account for asymmetrical loads which would result from evacuees inadvertently entering the pontoon areas during an emergency evacuation. For demonstration purposes, sand bags may be used.

4.4 Elimination of Static. The device and its fastening must be so constructed that static electricity will not be generated in sufficient quantity to cause a spark which would create a hazard if there is any fuel spillage nearby.

4.5 Damage Resistance and Usage.

4.5.1 The device must be capable of resisting puncture and tear of the sliding and walking surfaces and supporting structure from objects normally carried or worn by passengers that could result in collapse of the device, prevent the device from performing its intended function, or both.

device totally unusable.

4.6 Length. The slide device must be of such length after full deployment that the lower end is self-supporting on the ground and provides safe evacuation of occupants to the ground when the aircraft is on the ground with the landing gear extended and after collapse of one or more legs of the landing gear.

4.7 Elimination of Encumbrances. Encumbrances which might be grabbed by evacuees must be kept to a minimum consistent with good design for maximum operational efficiency.

4.8 Hardware and Attaching Means Strength. All hardware and all other connecting means (including webbing and straps) used in attaching the device to the aircraft and all straps, grips, and handhold members not associated with aircraft attachments must have strength not less than 1.5 times the highest design load imposed in showing compliance with the strength requirements of paragraph 4.3 (Part I).

4.9 Use as Re-entry Device. If the device is designed with additional provisions for use as a means of re-entering the aircraft, these additional provisions must not interfere with the use of the device for evacuation.

4.10 Use as a Flotation Device. Evacuation devices installed at main deck floor level exits, other than wing-to-ground, fillet mounted, tail cone, or ventral slides, and or aircraft not equipped with slide/rafts shall be designed to have positive buoyancy when extended and shall have a means to readily disconnect the device from the aircraft so that it can be used as an emergency flotation device. The method of disconnecting the device from the aircraft shall be conspicuously and clearly indicated by brief instruction placards. Disconnect means must be readily apparent, capable of being operated by untrained persons, and covered until ready for use. In addition, a mooring line shall be provided in such a manner that the device shall automatically remain secured to the aircraft when it is used as an emergency flotation platform and not endanger the device or cause the device to spill occupants if the aircraft sinks. The mooring line shall have a minimum length of 20 feet and have knotted breaking strength of not less than 500 lbs. The attachment to the evacuation device shall be stronger than the mooring line. The mooring line shall not interfere with operation of the device. It shall be possible to release the moored device from the aircraft quickly and easily after disconnecting the device from the aircraft. The release means shall be readily apparent and shall be capable of operation by untrained evacuees. In addition to

4.11 Evacuation Rate. The device must be capable, when dry, of handling evacuees at a rate of at least 60 adults per minute per lane at representative sill heights for a duration of at least 70 seconds.

4.12 Deployment. (NOTE: FAR § 25.809 (14 CFR 25.809) contains requirements pertaining to deployment and erection characteristics of the device as installed on the aircraft which may be taken into consideration along with the requirements in this TSO.)

4.13 Inflation.

4.13.1 An automatically inflatable device shall be designed to prevent its being inflated out of proper sequence so as to create an unsafe usage condition.

4.13.2 An automatically inflatable device must have a manual means for actuating inflation. The manual inflation actuating means must be neither visible nor presented for use until the device has been deployed.

4.14 Inflation Time. Except for wing-to-ground slides, the device must be automatically erected in 6 seconds after actuation of inflation controls is begun. The wing-to-ground slide, or wing-to-ground portion of a ramp/slide combination, must be erected in not more than 10 seconds after actuation of the inflation controls.

4.15 Extendible Length Slides

4.15.1 The extension of an extendible length slide must be capable of being inflated at any time after inflation of the basic slide has been initiated.

4.15.2 Inflation of the extension of an extendible length slide must be initiated by separate controls from those for the basic slide.

4.15.3 The junction of the basic slide and the extension of an extendible length slide must not impede evacuation.

4.16 Manual Inflation Actuation Controls.

4.16.1 Inflation actuation controls must be red in color with the word "pull" (or appropriate instruction) in letters at least 1/2-inch high and of a color contrasting with their immediate background.

the aircraft door.

4.16.4 Inflation actuation controls must be so designed that the maximum required pulling force will not pull the deployed device back into the doorway. The pulling force required must not exceed 30 pounds.

4.16.5 Cable-type inflation actuation controls must be constructed so they cannot trip or entangle evacuees.

4.17 Inflation System. The evacuation device and its inflation system must be connected and ready for instant use. Components of the inflation system must meet Department of Transportation Specification 3AA (49 CFR 178.37) or Specification 3HT (49 CFR 178.44) in effect May 30, 1976, as applicable, or an equivalent approved by the manager of the FAA office to which this TSO data is to be submitted, as required in paragraph (c), Data Requirements. The inflation system must be constructed to minimize leakage due to back pressure after inflation. If an air aspirator system is used, the system must be constructed either to prevent the ingestion of foreign objects or to prevent failure or malfunction as a result of ingestion of small foreign objects.

4.18 Double Lane Slides.

4.18.1 A double lane slide must provide space for evacuees sliding two abreast. Each sliding surface, if separated by a raised divider, must be at least 20 inches wide. The combined width of two sliding surfaces not separated by a raised divider must be at least 42 inches. The width of a dual lane slide with no raised lane divider must be sufficent to enable evacuees to jump side-by-side into the slide and reach the ground safely.

4.18.2 A double lane slide must resist adverse twisting or deflecting when subjected to maximum unsymmetrical loading determined from the evacuation rate prescribed in paragraph 4.11 (Part I) of this standard.

4.18.3 A raised divider or center median must be constructed so as to prevent injury to evacuees and not to throw from the slide evacuees who jumped into the slide astraddle or partly astraddle the divider or median.

4.20 Emergency Knife Location. If an emergency knife is provided, it must be so installed that it cannot injure persons using the evacuation device in a normal manner.

4.21 Self-illuminated Slides.

4.21.1 Self illuminated slides must be designed so the illumination means is activated automatically during deployment or inflation and the level of illumination meets the appropriate requirements in FAR § 25.812 (14 CFR 25.812) in effect on May 1, 1972.

4.21.2 The illuminating means must not interfere with the safe evacuation of persons using the slide in a normal manner.

4.22 Wind. The device must have the capability, in 25-knot winds directed from the most critical angle, to deploy and, with the assistance of only one person, to remain usable after full deployment to evacuate occupants safely to the ground.

4.23 Device Surface.

4.23.1 The device surface, including its coating, must be suitable and safe for use in any weather condition, including a rainfall of 1 inch per hour.

4.23.2 Each device sliding lane, including its coating, must provide safe and rapid evacuation without detrimental errosion or deterioration for at least 200 adult persons without any rework of the surface.

4.24 Device Performance. To ensure that the device performs its intended function, at least five consecutive deployment and erection tests must be demonstrated without failure. (NOTE: FAR § 25.809 (14 CFR 25.809) contains requirements pertaining to the installation of the device on the aircraft which may be taken into consideration along with the requirements in this TSO.)

4.25 Pressure Retention. An inflatable device must be designed to be capable of maintaining adequate pressure to accomplish satisfactorily its intended function throughout an emergency evacuation in which—

4.25.1 The device is installed at its critical angle (with respect to buckling);

4.25.4 At least 200 persons in no more than 10 separate demonstrations use each slide lane of the device at an average rate of not less than one person per second per lane.

4.26 Overpressure Tests.

4.26.1 The device must be shown by test to withstand a pressure at least 1.5 times the maximum slide mode operating pressure for at least 5 minutes without sustaining damage.

4.26.2 At least one specimen of the inflatable device model must be shown by test to withstand a pressure at least 2 times the maximum slide mode operating pressure without failure. Devices so tested must be clearly identified.

4.27 Leakage. In both the evacuation slide configuration and flotation device configuration required by paragraph 4.10, under static conditions and when inflated and stabilized at the nominal slide mode operating pressure, the pressure in each inflatable chamber must not fall below 50% of the nominal operating pressure in less than 12 hours.

5. Material Tests. The material tests required in paragraph 3.0 (Part I) of this standard must be conducted in accordance with the following test method or other approved equivalent methods:

	Test Method	
Tests Required	Federal Test Method Standard No. 191A dated July 20, 1978	Other Test Method
Accelerated Age	Method 5850	Per Note (1)
Tensile Strength (Grab Test)	Method 5100	Per Note (9)
Tear Strength(Trapezoid Test)	Method 5136 (4)	
Tear Strength (Tongue Test)	Method 5134 (Alternate to Trapezoid Test. See 3.1.4.1)	
Ply Adhesion	Method 5960	Per Note (3)
Coat Adhesion	Method 5970	Per Note(10)

Puncture Strength	Per Note (6)
Hydrolysis Conditioning	Per Note (7)
Porosity Test (Hydrolysis)	Per Note (8)

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(1) Samples for the accelerated aging tests must be exposed to a temperature of 158 ± 5 degrees F for not less than 168 hours. After exposure, the samples must be allowed to cool to 70 ± 2 degrees F for neither less than 16 hours nor more than 96 hours before determing their physical properties in accordance with 3.1 (Part I) of this standard.

(2) Each sample shall consist of two strips 2 inches maximum width by 5 inches maximum length bonded together with an overlap 3/4 inches maximum. The free ends must be placed in the testing machine described in Method 5100 and separated at a rate of 12 ± 0.5 inches per minute. The average value of two samples must be reported. Samples may be multilayered as required to provide adequate strength to ensure against premature material failure. Samples may be gripped across full two inches of width.

(3) Separation rate must be 2.0 to 2.5 inches per minute. Sample width shall be one inch.

(4) Federal Test Method Standard No. 191 in effect December 31, 1968.

(5) ASTM Method D1434-82, Procedure V, approved July 30, 1982, is an acceptable alternate method.

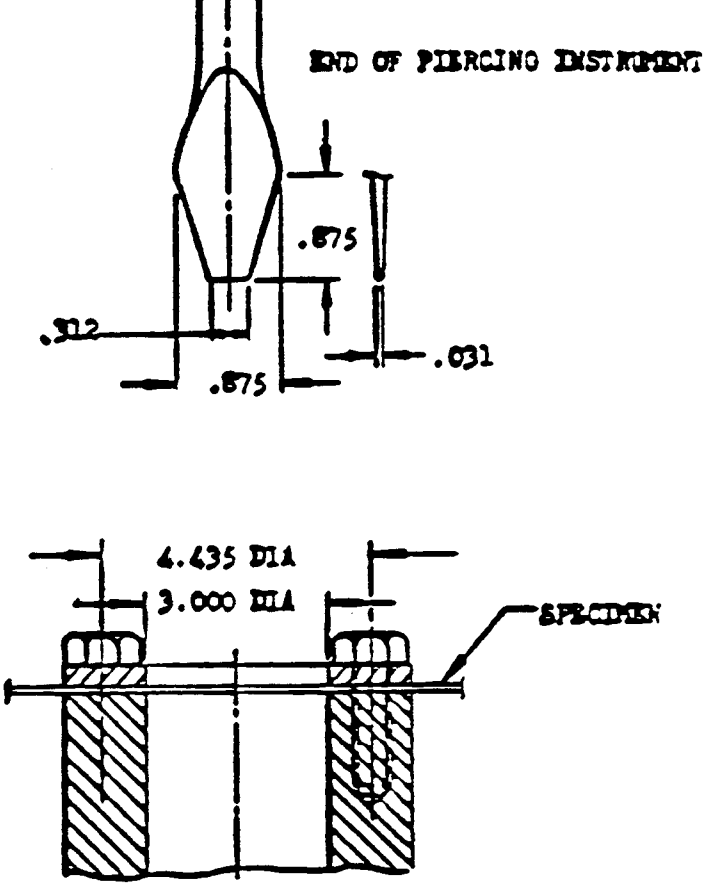
(6) The fabric shall be tested in a specimen holder constructed in accordance with Figure 1. The fabric shall be clamped tightly in the specimen holder to present a wrinkle-free surface and prevent slippage during the test. A piercing instrument with its end conforming to Figure 1 shall be forced against the fabric at approximately the center of the area enclosed by the specimen holder. The force required to puncture the specimen shall not be less than the specified 67 pounds. The test shall be run using a crosshead speed of 12 inches per minute.

(7) Each sample shall be exposed to a temperature of 58 ± 2 degrees C and a relative humidity of 95 ± 4 percent for a period of 50 days.

30 minutes. Porosity is indicated by a loss in chamber pressure during testing. Pressure loss for material specimens after hydrolysis conditioning shall not be greater than the pressure loss for the material before conditioning.

(9) Use of pneumatic grips for holding test samples is an acceptable alternate to the mechanical grips described in Method 5100.

(10) The sample shall be prepared using the adhesive and construction methods used to manufacture the evacuation slide. Separation rate must be 2.0 to 2.5 inches per minute.



SPECIMEN HOLDER

DIMENSION IN INCHES

FIGURE 1. PIERCING INSTRUMENT AND SPECIMEN HOLDER

aircraft which may be taken into consideration along with the requirements in this TSO.)

2. Scope. Part II of this standard provides for evacuation slides that are designed to be used also as liferafts.

3. Materials and Workmanship. The materials and workmanship of the slide/raft combination device must meet the requirements contained in paragraph 3.0 and 5.0 of Part I of this TSO. In addition, materials used in the construction of flotation chambers and decks must be capable of withstanding the detrimental effects of exposure to fuels, oils, and hydraulic fluids.

3.1 Canopy. Fabrics used for this purpose must be waterproof and resistant to sun penetration, must not affect the potability of collected water, and must meet the following minimum requirements in the applicable tests prescribed in paragraph 5.0 (Part I) of this standard, except that in lieu of meeting the tensile strength requirements, a fabricated canopy may be demonstrated to withstand 35-knot winds and 52-knot gusts:

Tensile Strength (Grab Test)
Warp 75 pounds/inch
Fill 75 pounds/inch

Tear Strength
Trapezoid Test: 4 x 4 pounds/inch; or
Tongue Test: 4 x 4 pounds/inch

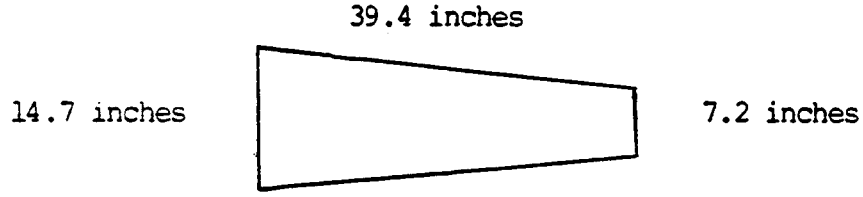
Coat Adhesion of Coated Fabrics
3.5 pounds/inch width at 70 $\pm$ 2 degrees F at a separation rate of 2.0 to 2.5 inches/minute

4. Design and Construction. The requirements of this paragraph 4.0 are applicable to the slide/raft combination device in the raft mode. In addition, the device must meet the design and construction requirements of paragraph 4.0 of Part I of this TSO.

4.1 Capacity. The rated and overload capacities of a slide/raft combination for the raft mode must be based on not less than the following usable sitting areas on the deck of the raft:

Rated Capacity	3.6 ft^2/person
Overload Capacity	2.4 ft^2/person

spaces which can be accommodated within the occupiable area exclusive of the perimeter structure (such as buoyancy tubes) without overlapping of the occupant seating spaces. The occupant seating spaces may not be less than the following size (or an equivalent size approved by an aircraft certification office).



4.1.1.2 The rated capacity of the slide/raft may be determined on the basis of a controlled pool or fresh water demonstration which includes conditions prescribed under paragraph 5.3.1 (Part II) of this standard and the following:

4.1.1.2.1 The sitting area on the slide/raft deck may not be less than 3.0 feet^2/person.

4.1.1.2.2 At least 30 percent but no more than 50 percent of the participants must be female.

4.1.1.2.3 Except as provided below, all participants must select their sitting space without outside placement assistance. A slide/raft commander, acting in the capacity of a crewmember, may direct occupant seating to the extent necessary to achieve reasonable weight distribution within the slide/raft.

4.1.1.2.4 All participants must not have practiced, rehearsed, or have had the demonstration procedures described to them within the past 6 months.

4.2 Buoyancy.

4.2.1 Buoyancy must be provided by two independent buoyancy tubes each of which, including the slide/raft floor, must be capable of supporting the rated and overload capacities in fresh water if the other tube is deflated.

4.2.2.2 Six inches with the critical flotation tube deflated and the remaining flotation tube at minimum raft mode operating pressure. In lieu of meeting the 6-inch freeboard requirement of this paragraph, the buoyancy provided by the tubes only (disregarding buoyancy derived from the floor and inflatable floor support) must be capable of supporting the rated capacity based on an average weight of at least 200 pounds per person.

4.2.3 It must be shown by tests in fresh water that the slide/raft loaded to its overload capacity and using an average weight of at least 170 pounds per person has a measurable freeboard with the critical flotation tube deflated. Ballast in the form of sand bags or equivalent may be used to achieve the 170 pound average, provided the appropriate weight distribution within the slide/raft is maintained.

4.3 Inflation Time. In addition to meeting the slide inflation requirements in paragraph 4.14 (Part I) of this standard, if there is a transition from slide mode to raft mode, the transition time must not be more than 10 seconds after actuation of the conversion means.

4.4 Canopy. A canopy must be packed with or attached to the slide/raft. The erected canopy must be capable of withstanding 35-knot winds and 52-knot gusts in open water. The canopy must provide adequate headroom and must have provision for openings 180 degrees apart. Means must be provided to make the openings weathertight. If the canopy is not integral with the raft, it must be capable of being erected by occupants following conspicuously posted, simple instructions. It must be capable of being erected by one occupant of an otherwise empty slide/raft and by occupants of a slide/raft filled to rated capacity.

4.5 Capsize Resistance. There must be water pockets or other means to provide capsize resistance for an empty or lightly loaded raft.

4.6 Righting. Unless it is shown that there is no tendency for the slide/raft to become inverted during loading and release from the aircraft, the slide/raft must be capable of being righted by a person in the water unless the slide/raft while inverted provides accessible manual inflation valves and equipment, boarding aids, and flotation for its rated capacity.

slide or raft mode of operation.

4.8 Boarding Aids. Boarding aids must be provided at two opposing positions on the slide/raft. Boarding aids must permit unassisted entry from the water into the unoccupied raft and must not at any time impair either the rigidity or the inflation characteristics of the raft. Puncturing of inflatable boarding aids must not affect the buoyancy of the raft buoyancy chambers. Boarding handles and/or stirrups used in conjunction with the boarding aids must withstand a pull of 50 pounds.

4.9 Heaving-trailing Line. At least one floating heaving-trailing line not less than 75 feet in length and at least 250 pounds strength must be located on the main flotation tube near the sea anchor attachment. The attach point of the line must withstand a pull of not less than 1.5 times the line rated strength without damage to the slide/raft.

4.10 Mooring Line. A nonrotting mooring line at least 20 feet in length must be attached at one end to the slide/raft. The mooring line must be capable of keeping the slide/raft, loaded to maximum rated capacity, attached to a floating aircraft, and not endanger the slide/raft or cause the slide/raft to spill occupants if the aircraft sinks. The line may be equipped with a mechanical release linkage. The breaking strength of the line must be at least 500 pounds, or 40 times the rated capacity of the slide/raft, whichever is greater, but need not exceed 1,000 pounds.

4.11 Inflation System. In addition to meeting the requirements of paragraph 4.17 (Part I) of this standard, the inflation system must be arranged so that failure of one inflatable chamber or manifold will not result in loss of gas from the other chambers. The inflation equipment must be located so as not to interfere with boarding operations.

4.12 Color. Except surfaces which have been treated for the purpose of reflecting radiant heat, the color of the slide/raft surfaces, including the canopy surface, visible from the air must be an International Orange-Yellow or an equivalent high visibility color.

4.13 Sea Anchor. A sea anchor, or anchors, or other equivalent means must be provided to maintain the raft, with rated capacity and canopy installed, on a substantially constant heading relative to the wind and have the ability to reduce the drift to 2 knots in 17 to 27-knot winds. Unless analysis and/or test data substantiating the adequacy of a lower breaking strength is approved by the manager of the FAA office to which this TSO data is to be submitted as required in paragraph (c), Data Requirements, the line securing a sea anchor to the slide/raft must have a breaking strength of 500 pounds or 40 pounds time the rated capacity of the raft, whichever is greater. The attachment of the line to the raft

the slide/raft, and having a displacement of at least [illegible] full stroke, must be provided to manually inflate and maintain chambers at raft mode minimum operating pressure. Manual inflation valves, with a nonreturn opening adequate for the size and capacity of the inflation means, must be located to permit inflation of all chambers. The inflation means and valves must have provisions to prevent inadvertent removal and loss when either stowed or in use.

4.15 Knife. A hook-type knife secured by a retaining line must be sheathed and attached to the slide/raft adjacent to the point of mooring line attachment.

4.16 Placards. Suitable placarding must be provided in contrasting colors in waterproof paint which is not detrimental to the fabric, that denotes use and location of the inflation systems, raft equipment, boarding aids, and righting aids. The letters used for such placarding must be at least 2 inches, high except the details and miscellaneous instructions may be of smaller lettering. Applicable placarding must take into account persons boarding or righting the raft from the water.

4.17 Lights. One or more survivor locator lights must be provided that are approved under TSO-C85. The lights must be automatically activated upon slide/raft inflation in the water, and visible from any direction by persons in the water.

4.18 Release from Aircraft. Release of the slide/raft from an aircraft, whether by automatic or manual means, must not be restricted by the critical conditions of: (a) floor sill height above the water, (b) wind velocity and direction, or (c) occupant load. Devices having aircraft mounted inflation systems must have means for quick detachment from the inflation system so that separation cannot cause loss of raft buoyancy. Disconnect means must be readily apparent, capable of being operated by untrained persons, and covered until ready for use.

4.19 Actuation Means. If the device as a slide requires an additional operation to make it usable as a raft, the means for initiating the additional operation must be designed to preclude inadvertent actuation but be readily available for use. If a pull motion is used, the force required must not be more than 35 pounds.

4.20 Hardware and Attaching Means. All hardware, all connecting means (including webbing and straps) used in attaching the raft to the aircraft, and all straps, grips and handhold members not associated with aircraft attachments must have a strength not less than 1.5 times the highest design load imposed in establishing the rated capacity under paragraph 4.1 (Part II) of this standard.

5.1 Pressure Retention. Under static conditions and when inflated and stabilized at the nominal operating pressure, the pressure in each inflatable chamber must not fall below the minimum raft mode operating pressure in less than 24 hours. The minimum raft mode operating pressure is the pressure required to meet the minimum design buoyancy requirements of paragraph 4.2 (Part II) of this standard.

5.2 Overpressure Tests.

5.2.1 The device must be shown by test to withstand a pressure at least 1.5 times the maximum raft mode operating pressure for at least 5 minutes without sustaining damage.

5.2.2 At least one specimen of the inflatable device model must be shown by test to withstand a pressure at least 2 times the maximum raft mode operating pressure without failure. Devices so tested must be clearly identified.

5.3 Functional Tests. Each slide/raft model must pass the following tests:

5.3.1 Water Tests. In either a controlled pool or fresh water, the slide/raft combination capacity and buoyancy must be demonstrated as follows:

5.3.1.1 Both rated and overload capacities established in accordance with the requirements of paragraph 4.1 (Part II) of this standard must be demonstrated with inflation tubes at minimum raft mode operating pressure and with the critical buoyancy chamber deflated. The resultant freeboard in each case must meet the requirements of paragraph 4.2 (Part II) of this standard.

5.3.1.2 Persons used in the demonstration must have an average weight of not less than 170 pounds. Ballast in the form of sand bags or equivalent may be used to achieve proper loading provided the appropriate weight distribution within the slide/raft is maintained.

5.3.1.3 Persons used in the demonstration must wear life preservers with at least one chamber inflated.

5.3.1.4 The required raft equipment, including one emergency locator transmitter or a weight simulating a transmitter, must be aboard the raft.

5.3.1.6 It must be demonstrated that the boarding aids are adequate for the purpose intended and that it is possible for an adult wearing an inflated life preserver to board the raft unassisted.

5.3.2 Sea Trials. The slide/raft must be demonstrated by tests or analysis, or a combination of both, to be seaworthy in an open sea condition of 17 to 27-knot winds and waves of 6 to 10 feet. In tests, ballast in the form of sand bags or equivalent may be used to achieve proper loading provided the appropriate weight distribution within the slide/raft is maintained. If analysis is used, the analysis must be approved by the manager of the FAA office to which the TSO data is to be submitted as required in paragraph (c), Data Requirements. For this seaworthiness demonstration, the following apply —

5.3.2.1 The raft must be boarded by the rated number of occupants to demonstrate the method of loading from a simulated aircraft sill installation.

5.3.2.2 The proper functioning of the means to separate the raft from the simulated aircraft installation must be demonstrated.

5.3.2.3 All required equipment must be aboard and the proper functioning of each item of equipment must be demonstrated.

5.3.2.4 The canopy must be erected for a sufficient time to assess its resistance to tearing and the protection it affords. The method of erection must be shown to be accomplished by one occupant of an otherwise empty raft, and by occupants of a raft filled to rated capacity.

5.3.2.5 The stability of the raft must be demonstrated when occupied at normal rated capacity and at 50 percent rated capacity.

effectiveness of the device in the emergency evacuation mode, must be tested for resistance to radiant heat in accordance with this standard. If any of the outer surface of the pressure holding material is altered by marking, by lettering, by affixed overlay material, or in any other manner which affects radiant heat resistance, the altered material must be tested also. The tests must be conducted using the FAA Slide Material Radiant Heat Apparatus, or another equivalent test apparatus and test method approved by the manager of the FAA office to which this TSO data is to be submitted as required in paragraph (c), Data Requirements. For each material which requires testing, at least three specimens must be tested at 1.5 Btu/ft^2-sec, and the resulting times to failure averaged. The average time to failure may not be less than 90 seconds. Time to failure is the time between first application of heat to the specimen and first drop in pressure below the maximum pressure attained in the test cylinder during the test.

2. Apparatus. The FAA Slide Material Radiant Heat Apparatus consists of a horizontally mounted cylinder closed at one end and fitted with a source of air pressure and pressure measurement. A specimen holder clamped over the open end seals the cylinder air tight with the material specimen acting as a pressure holding diaphram. The cylinder and specimen holder are mounted on a pivot and slide bar, and can be positioned at varying distances from a 3-inch diameter electric radiant heat furnace and a calorimeter. Details of the test apparatus are described in Figure 1 through 4 and paragraphs 2.1 through 2.6, below.

2.1 The pressure cylinder and specimen holder as shown in Figures 1, 2, and 3 consist of a 7-inch outside diameter (O.D.) by 6 1/2-inch inside diameter (I.D.) by 12 3/8-inch long aluminum tube. On one end of the tube is welded a 1/2-inch thick aluminum plate, drilled and tapped for a 1/4 inch American national pipe taper thread to facilitate air pressure and pressure recording hookups. On the other end of the tube is welded a 7-inch O.D. by 5 1/2-inch I.D. ring of 1/2-inch thick aluminum. This ring is drilled and tapped for 10-32 by 7/8 - inch long studs. Another 6 3/4-inch O.D. by 5 1/2-inch I.D. by 1/2 inch thick aluminum ring and two neoprene rubber gaskets with matching clearance holes to fit over the studs provide a means for clamping and sealing the test specimen in place. Hinges and adjustable stops are welded to the sides of the cylinder, shown in Figures 1, 2, and 3.

2.2 An electric furnace, Figure 4, with a 3-inch diameter opening is used to provide a constant irradiance on the specimen surface. The National Bureau of Standards smoke chamber radiant heat furnace, available from Superpressure Inc., 8030 Georgia Avenue, Silver Spring, Maryland 20910, is recommended.

2.4 The pressure cylinder, calorimeter, and furnace are mounted on a framework as detailed in Figure 3. Adjustable sliding stops are located on each of the bars for setting the cylinder and calorimeter at the desired distance from the opening of the furnace.

2.5 Compressed air is connected to the cylinder through a needle valve attached to the end of the framework. A tee on the outlet side of the valve provides for a 0-5 psig pressure gage, transducer, and flexible tube to supply air to the rear plate of the pressure cylinder, as shown in Figure 1.

2.6 The outputs of the calorimeter and pressure transducer are measured and recorded using a recording potentiometer or other suitable instrument capable of measurement over the range required.

3. Acceptable Test Procedure for FAA Apparatus.

3.1 Test specimens 7 inches (178mm) in diameter with 1/4-inch (6mm) holes puched in the material to match the studs in the pressure cylinder must be cut from the material to be tested.

3.2 Test specimens must be conditioned at 70 $\pm$ 3 degrees F and 50 $\pm$ 5 percent relative humidity for at least 24 hours prior to testing.

3.3 All tests must be conducted in a draft free room or enclosed space.

3.4 After turning on the radiant heat furnace and other required instrumentation, allow 1/2 to 3/4 hour to stabilize heat output and for instrumentation warmup.

3.5 Adjust transformer to produce a radiant heat flux of 2 Btu/ft^2-sec, when the calorimeter is positioned 1 1/2 inches (38mm) in front of the radiant heat furnace.

3.6 Find the location in front of the furnace for the test heat flux of 1.5 Btu/ft^2-sec, by sliding the calorimeter on the horizontal bar and fixing the position with the sliding stop. Swing the Calorimeter out of position.

3.8 Pressurize the cylinder to the slide nominal operating pressure. Check for leakage.

3.9 Check the distance from the radiant heat furnace to the surface of the test specimen. This distance is the same as the distance to the surface of the calorimeter.

3.10 Place the calorimeter in front of the radiant heat furnace and record the heat flux. An accepable heat flux is 1.5 Btu/ft^2-sec. Remove calorimeter.

3.11 Place the pressure cylinder and test specimen in front of the radiant heat furnace. Start timer or note starting time on the recorder.

3.12 Pressure is monitored from the time the specimen is placed in front of the furnace until initial pressure loss is observed.

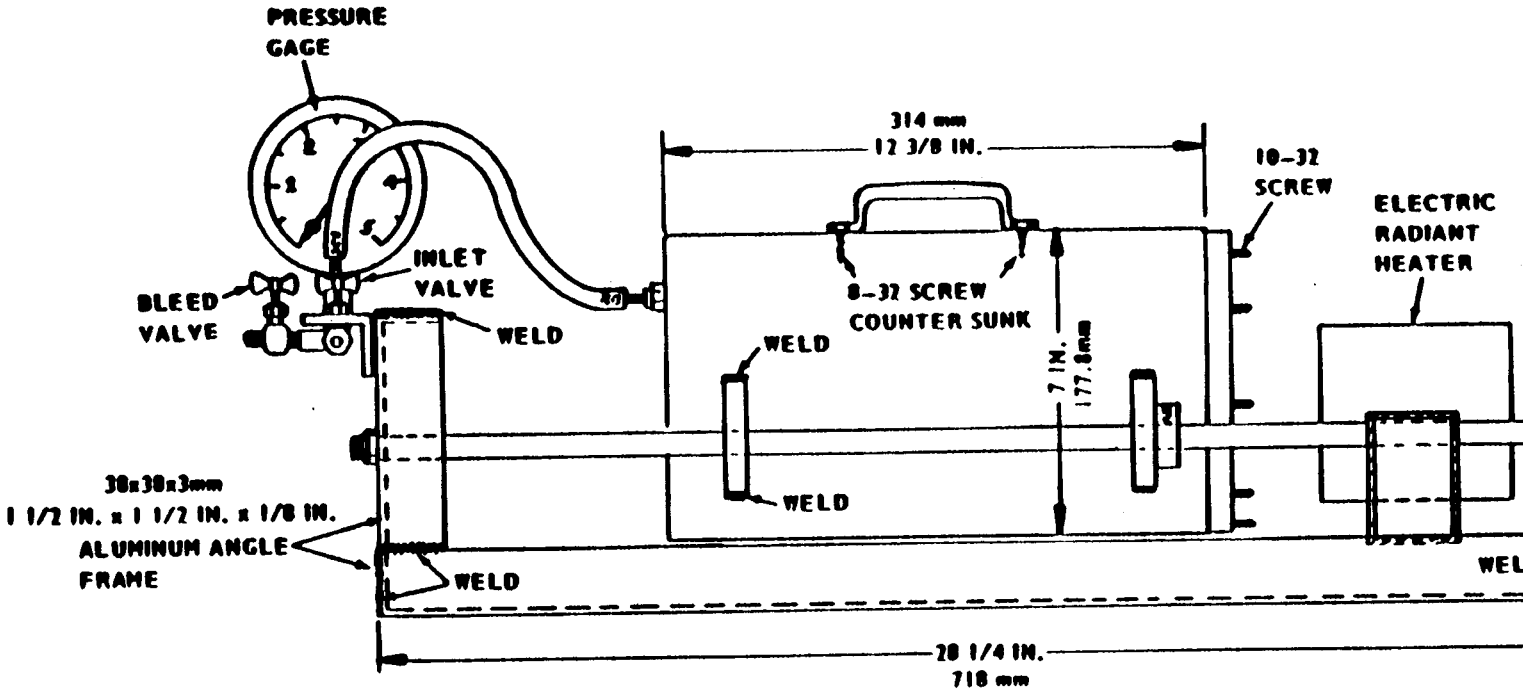


FIGURE 1. LABORATORY TEST (FRONT VIEW)

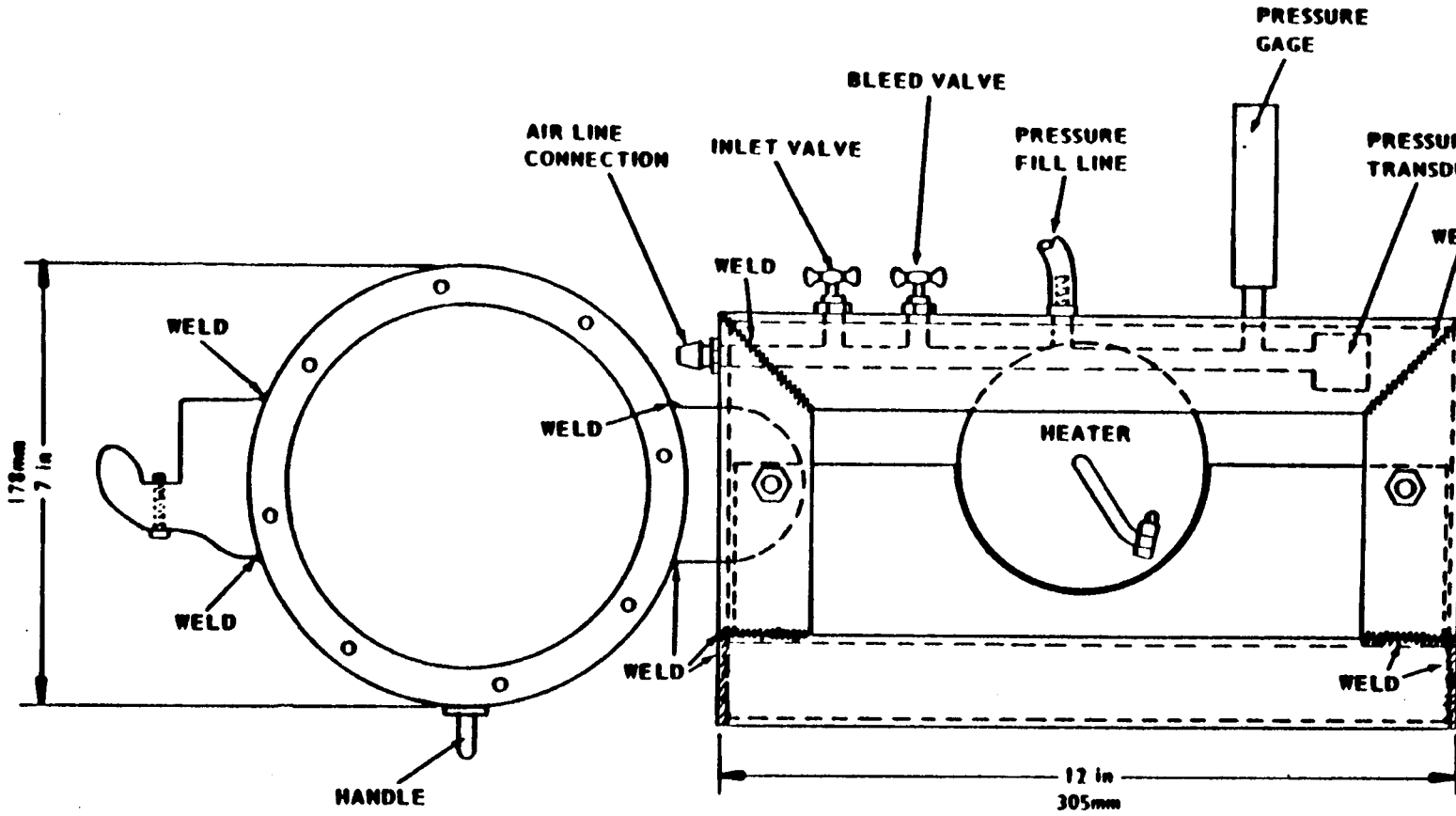


FIGURE 2. LABORATORY TEST (SIDE VIEW)

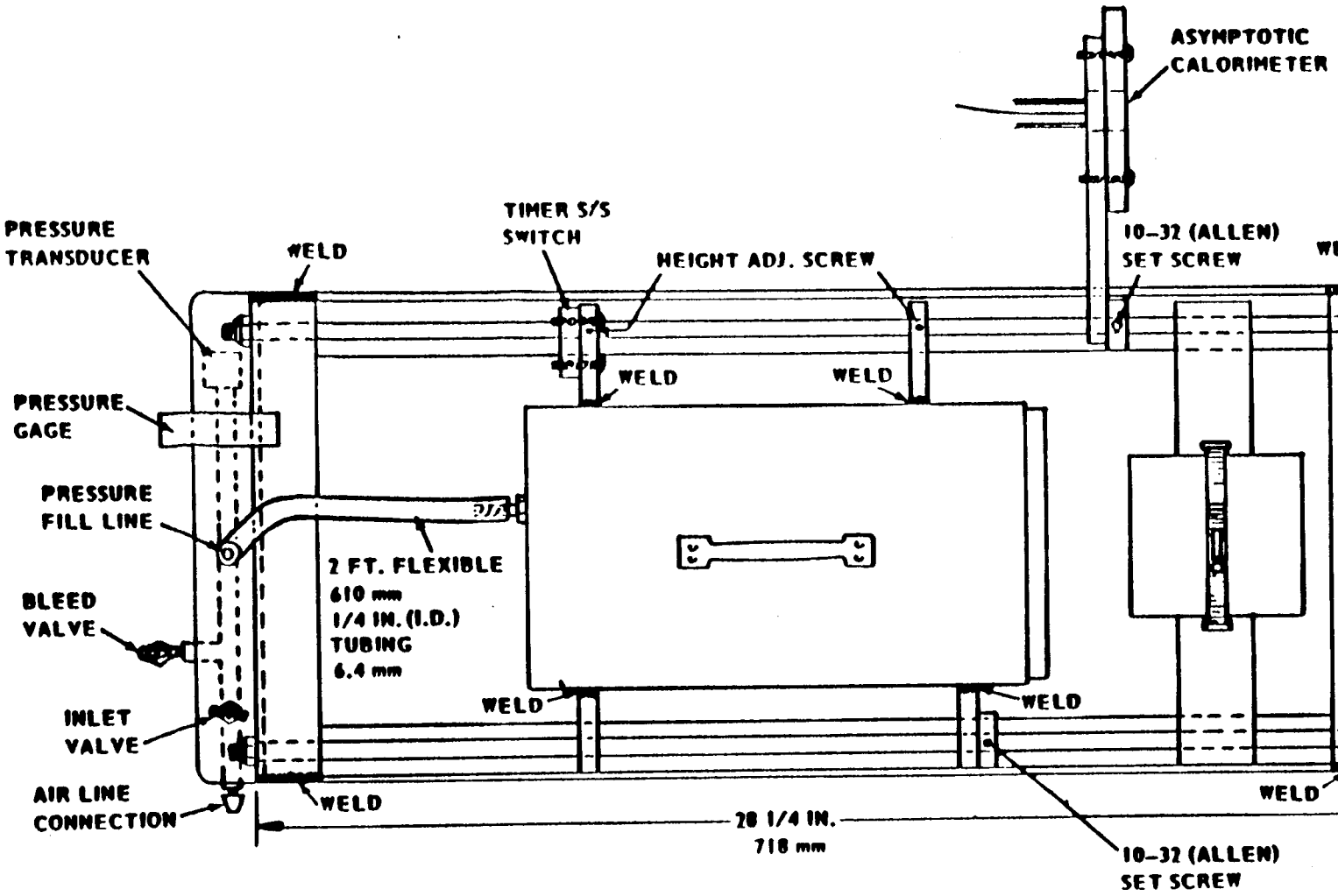
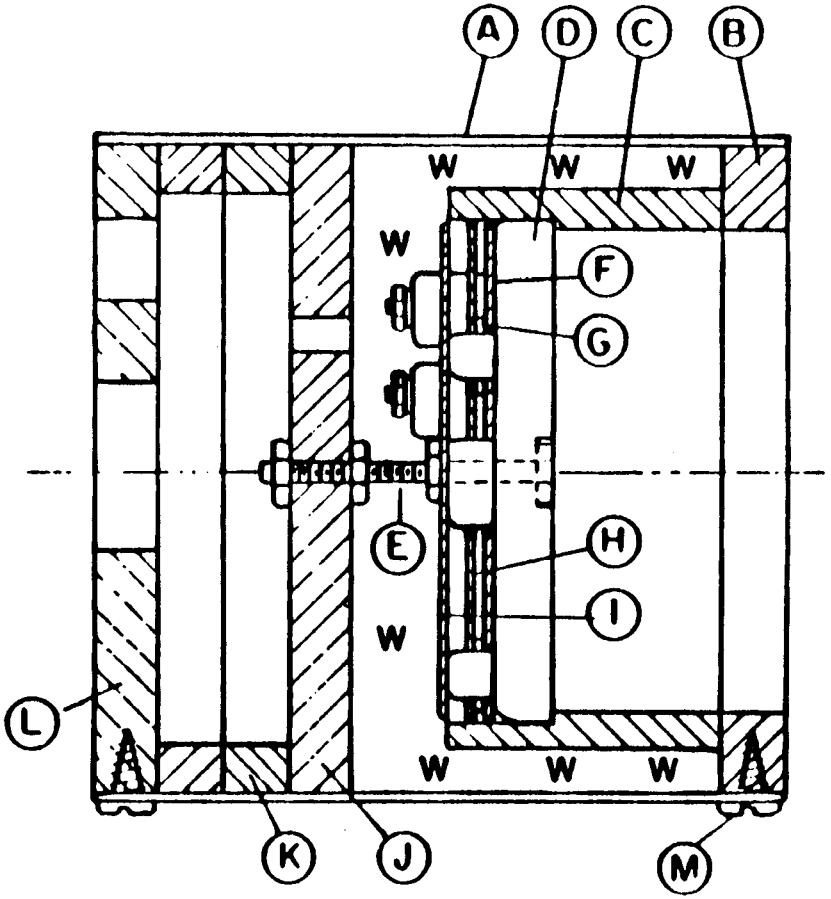


FIGURE 3. LABORATORY TEST (TOP VIEW)



A - STAINLESS STEEL TUBE
B - ASBESTOS BOARD
C - CERAMIC TUBE
D - HEATING ELEMENT, 525 W
E - STAINLESS STEEL SCREW
F - ASBESTOS PAPER GASKET
G - STAINLESS STEEL SPACING WASHERS (3)
H - STAINLESS STEEL REFLECTOR
I - STAINLESS STEEL REFLECTOR
J - ASBESTOS BOARD
K-ASBESTOS BOARD RINGS
L-ASBESTOS BOARD COVER
M-SHEET METAL SCREWS
W-PYREX GLASS WOOL

FIGURE 4. FURNACE SECTION